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Inside this issue: Chikungunya virus

Chikungunya virus causes a dengue-like illness and, over the past year, has had a remarkable spread across the Caribbean as well as parts of southern Europe and the United States. This issue explores what the implications are for Canada in terms of travel-related illness, and the risk that the mosquito vector could migrate north. See the *ID News* links to explore *how* chikungunya and other alpha viruses cause arthritic symptoms. Also included in this issue are our thanks to CCDR's 2014 peer reviewers and our updated *Information for authors*.

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Public Health Agency of Canada: **Chikungunya: Global Update.**
http://travel.gc.ca/travelling/health-safety/travel-health-notices/chikungunya-global

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Chen W, Foo SS, Rulli NE, Taylor A, Sheng KC, et al. **Arthritogenic alphaviral infection perturbs osteoblast function and triggers pathologic bone loss**. *Proc Natl Acad Sci.* 2014 Apr 22; 111(16):6040–5. doi: 10.1073/pnas.1318859111. Epub 2014 Apr 14. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4000821/

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Canada

Travel-related chikungunya cases in Canada, 2014

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Abstract

Since the spring of 2014, there has been a large increase in travel-related chikungunya cases diagnosed in Canada. As of December 9, 2014, 320 confirmed and 159 probable cases have been diagnosed in Canada, with the majority of provinces identifying at least one imported case. This surge in Canadian infections has been associated with the incursion of chikungunya virus into the Caribbean and the expansion of the virus in the Americas. Ongoing outbreaks in the Asia-Pacific region have also contributed to imported cases among Canadian travellers. Heightened awareness of chikungunya among clinicians is key to diagnosis. This highlights the need to ask for a travel history from anyone who presents with fever or recent onset of polyarthralgia, and to consider testing by provincial laboratories and the National Microbiology Laboratory for chikungunya virus and other diseases as indicated. Also essential is continued communication with travellers regarding the use of preventative measures to decrease the risk of exposure to mosquitoes when travelling to endemic areas.

Introduction

Chikungunya is a mosquito-borne viral illness that until recently was only endemic in countries in Africa, Asia, and the Indian and Pacific Oceans. In December 2013, however, two non-imported, confirmed cases of chikungunya on the Caribbean island of Saint-Martin/Sint Maarten were reported to the Pan American Health Organization (PAHO) (1). These cases marked the first incursion of chikungunya virus into the western hemisphere. During 2014, local transmission was detected in over 40 countries or territories in the Caribbean, Central America, South America, Mexico, and the United States (2,3) (**Table 1**).

Table 1: Countries and territories where locally transmitted/autochthonous chikungunya cases have been reported (2, 4)

Africa	Americas		Asia
Benin	Anguilla	Montserrat	Bangladesh
Burundi	Antigua and Barbuda	Nicaragua	Bhutan
Cameroon	Aruba	Panama	Cambodia
Central African Republic	Bahamas	Puerto Rico	China
Comoros	Barbados	Saint Barthelemy	India
Democratic Republic of Congo	Belize	Saint Kitts and Nevis	Indonesia
Equatorial Guinea	Brazil	Saint Lucia	Laos
Gabon	British Virgin Islands	Saint-Martin	Malaysia
Guinea	Cayman Islands	Saint Vincent, the Grenadines	Maldives
Kenya	Columbia	Sint Maarten	Myanmar (Burma)
Madagascar	Costa Rica	Suriname	Pakistan
Malawi	Curacao	Trinidad and Tobago	Philippines
Mauritius	Dominica	Turks and Caicos Islands	Singapore
Mayotte	Dominican Republic	U.S. Virgin Islands	Sri Lanka
Republic of Congo	El Salvador	United States (Florida)	Thailand
Reunion	French Guiana	Venezuela	Timor
Senegal	Grenada		Vietnam
Seychelles	Guatemala		Yemen
Sierra Leone	Guadeloupe		

South Africa	Guyana	**Oceania/Pacific Islands**	**Europe**
Sudan	Haiti	Federal States of Micronesia	France
Tanzania	Jamaica	New Caledonia	Italy
Uganda	Martinique	Papua New Guinea	
Zimbabwe	Mexico		

No local transmission of chikungunya virus has yet occurred in Canada likely due to the absence of the primary mosquito vectors—*Aedes aegypti* and *Aedes albopictus*. However, Canadians make over 2.5 million visits to Caribbean countries annually (5) and also travel in significant numbers to the Asia-Pacific region where continuing outbreaks of chikungunya and other mosquito-borne agents are increasing and Canadian cases have been identified (6,7). In this article, we review the disease, describe the dramatic increase in the number of countries now reporting chikungunya virus, and report the increase in travel-related chikungunya virus cases diagnosed in Canada in 2014 compared to previous years.

Clinical features

Symptoms generally appear three to seven days after someone is bitten by an infected mosquito; this typically begins with an abrupt onset of fever and polyarthralgia (8,9). Joint pain is usually symmetric, typically occurring in the hands and feet, and may be debilitating. Rash, headache, conjunctivitis, nausea and fatigue can also occur. Lymphopenia, thrombocytopenia, and elevated creatinine, and hepatic transaminases are common clinical laboratory findings (2). The most common differential diagnosis is dengue fever (9); however, cases have also been reported involving co-infections of both dengue and chikungunya viruses (10). Symptoms are generally self-limiting and last for two to three days; however, arthralgias may persist for weeks or even months. While most patients recover fully, occasional cases of eye, neurological and heart complications have been reported. Treatment is symptomatic and supportive; no vaccines are currently available.

Laboratory diagnosis

Suspect cases involving Canadian travellers should be tested for chikungunya immunoglobulin M (IgM) antibodies and confirmatory assays involving the presence of specific neutralizing antibodies (2, 11). Travellers who become ill immediately following a trip can also be screened for viral ribonucleic acid (RNA) using polymerase chain reaction-based (PCR-based) procedures, since patients may be viremic for up to a week or more. Isolation of virus is also a consideration for acute cases. All chikungunya testing is currently carried out at the National Microbiology Laboratory (NML). Commercial IgM enzyme-linked immunosorbent assay (ELISA) kits are also now available and are being validated by both the U.S. Centers for Disease Control and Prevention (CDC) and NML for "front line" testing considerations.

Given some of the overlapping symptoms, the differential diagnosis should include not only chikungunya but also other mosquito-borne diseases such as dengue and to consider testing for malaria, Zika virus and Japanese encephalitis virus depending on the travel history.

Epidemiology of chikungunya in Canada and the Americas

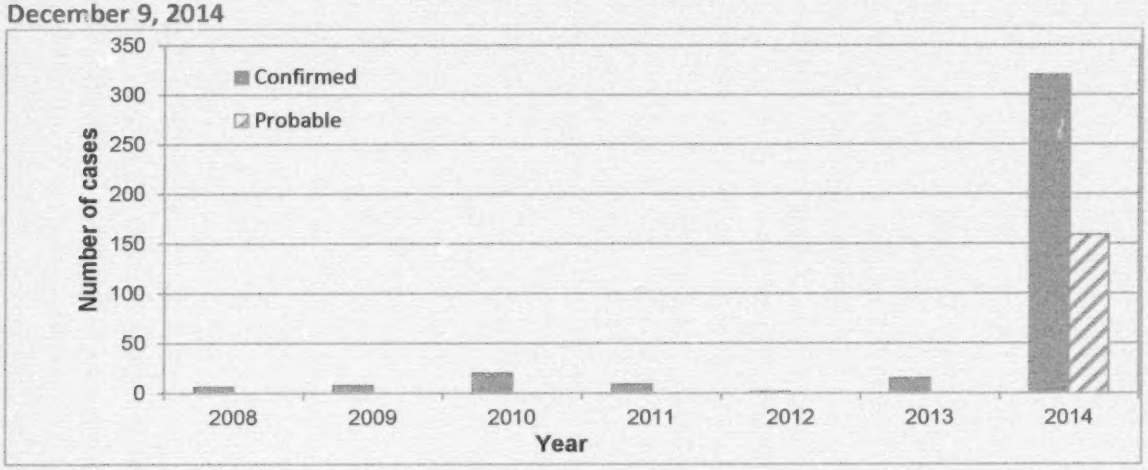
As of December 29, 2014, PAHO had reported over 1 million locally transmitted suspect cases, with almost 23,000 of these being laboratory confirmed (2, 4). The United States reported 2,320 imported cases, as well as 11 cases which were locally transmitted in Florida.

Chikungunya is not nationally notifiable in Canada, but the number of cases identified by diagnostic testing requested at NML provides an indication of how many Canadians are affected by the virus. In previous years, case numbers ranged from one to twenty cases a year from approximately 200 submissions for testing.

As of December 9, 2014, 320 confirmed and 159 probable cases (IgM positive, confirmatory testing pending) have been identified in Canada by laboratory testing among travellers returning from affected areas in both the Americas and the Asia-Pacific region (**Figure 1**). In addition, there are over 100 suspect cases that are still in the process of being tested by screening serological procedures for the month of December 2014.

In 2014, the number of samples sent for testing increased to over 1800 sera indicating both heightened awareness of the outbreak and an increase in suspect cases with clinical symptoms consistent with chikungunya disease.

Figure 1: Number of cases of travel-related chikungunya diagnosed in Canada, January 2008 to December 9, 2014



The majority of cases with documented travel histories had travelled to the Caribbean where intense viral transmission has been occurring since the spring of 2014. The first confirmed case with travel to the Caribbean was identified in a Québec resident who had visited Martinique in mid-January 2014 and returned to Canada in early February (C. Therrien and M. Drebot, personal communication, 2014).

The majority of provinces have confirmed cases (Quebec 114, Ontario 165, Alberta 14 and British Columbia 14, Manitoba 7, Saskatchewan, New Brunswick and Newfoundland all had < 5 cases each). In addition, approximately 20% of patients tested were viremic based on PCR detection of viral RNA in serum samples. This would have implications for local transmission in Canada if *Aedes* species mosquito vectors capable of transmitting were to become established in any of the provinces.

Conclusion

Over the course of 2014, there has been a rapid increase in the number of cases of chikungunya detected in Canada. With 320 confirmed and 159 probable cases (as of December 9, 2014), this is the largest yearly number of chikungunya cases ever documented in this country. In all likelihood, this is an underestimate due to missed diagnoses and undetected cases of mild disease.

A further exploration of travel history will help us to better understand the sources of chikungunya in Canadian travellers. It is likely that the increase in cases in 2014 has been associated with travel to the Caribbean, although ongoing outbreaks in the Asia-Pacific region may have contributed to case numbers detected in 2014 as well.

Chikungunya is not a nationally notifiable disease in Canada, but detection of cases by laboratory confirmation is useful in tracking its impact. Patients with clinical symptoms consistent with chikungunya disease, who have recently returned from travel from countries where the virus is circulating, should be tested for exposure to the virus. The laboratory diagnostic algorithm involves both serological and molecular diagnostic procedures to identify patients with the disease. Acute sera are screened for the presence of IgM antibodies and positive samples are then tested for the presence of virus-specific neutralization antibodies and viral RNA. Submission of convalescent sera is encouraged since the testing of convalescent samples will document seroconversions; in addition, acute sera from suspect cases may not always contain measurable levels of IgM and IgG which would be detectable in a follow up serum specimen.

The increase in chikungunya cases in Canada in 2014 merits increased awareness among travellers and clinicians of the risks from vector-borne diseases and how to prevent infection. Preventative measures are similar to those used to prevent all mosquito transmitted diseases (12).

The Government of Canada has issued a Travel Health Notice on chikungunya recommending that travellers protect themselves from mosquito bites when visiting areas where chikungunya may occur. Travellers are advised to contact a health care professional if symptoms develop while they are travelling or after they return to Canada and to inform the health care professional where they have been travelling or living (13).

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Conflict of interest

None

References

(1) Omarjee R, Prat C, Flusin O, Boucau S, Tenebray B, Merle O, Huc-Anais P, Cassadou S, Leparc-Goffart I. Importance of case definition to monitor ongoing outbreak of chikungunya virus on a background of actively circulating dengue virus, St Martin, December 2013 to January 2014. Eurosurveillance. 2014;19:pii:20753.

(2) Pan American Health Organization. Number of reported cases of chikungunya fever in the Americas—EW 40 (October 24, 2014). http://www.paho.org/hq/index.php?option=com_topics&view=article&id=343&Itemid=40931

(3) Powers AM. Risks to the Americas associated with the continued expansion of Chikungunya virus. J Gen Virol. 2014 Sep 19. pii: vir.0.070136-0. doi: 10.1099/vir.0.070136-0.

(4) Centers for Disease Control and Prevention. Countries and territories where chikungunya cases have been reported (as of June 17, 2014). http://www.cdc.gov/chikungunya/pdfs/ChikungunyaMap.pdf

(5) Statistics Canada. International Travel Survey, Canadian Residents, 2012.

(6) Roth A, Mercier A, Lepers C, Hoy D, Duituturaga S, Benyon E, Guillaumot L, Sourares Y. Concurrent outbreaks of dengue, chikungunya, and Zika virus infections—An unprecedented epidemic wave of mosquito-borne viruses in the Pacific 2012–2014. Eurosurveillance 2014;19:pil=20929.

(7) Schwartz KL, Giga A, Boggild AK. Chikungunya fever in Canada: Fever and polyarthritis in a returned traveller. CMAJ. 2014 Jul 8;186(10):772–4. doi: 10.1503/cmaj.

(8) Morrison TE. Reemergence of chikungunya virus. J Virol. 2014;88:11644–7.

(9) Deilgat M, Geduld J, Drebot M. Chikungunya outbreak in the Caribbean 2013–2014. CCDR. 2014 Jan;40(2):7–12. www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40-02/dr-rm40-02-chik-eng.php

(10) Chang SF, Su CL, Shu PY, Yang CF, Liao TL, Cheng CH, Hu HC, Huang JH. Concurrent isolation of chikungunya virus and dengue virus from a patient with coinfection resulting from a trip to Singapore. J Clin Microbiol. 2010 Dec;48(12):4586-9. doi: 10.1128/JCM.01228-10.

(11) Centers for Disease Control and Prevention. Chikungunya—Information for healthcare providers. http://www.cdc.gov/chikungunya/pdfs/CHIKV_Clinicians.pdf

(12) Committee to Advise on Tropical Medicine and Travel. Statement on personal protective measures to prevent arthropod bites. Communicable Disease Report 2012; 38(ACS-3).http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/12vol38/acs-dcc-3/index-eng.php

(13) Government of Canada Travel Health Notice. Chikungunya: Global update. http://travel.gc.ca/travelling/health-safety/travel-health-notices/chikungunya-global

Diagnostic challenges in chikungunya infection: Report of an atypical presentation

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Abstract

Due in part to increasing global travel, chikungunya fever has emerged as a significant public health concern. With recent outbreaks in Caribbean nations and the first report of locally acquired infection in the United States, there is concern that we may see an increasing number of cases in Canada. As chikungunya fever shares many clinical similarities to other arthropod-borne illnesses such as dengue fever, clinical diagnosis is challenging. We report an atypical presentation of acute chikungunya fever in a man returning from travel to Haiti. Microbiologic diagnosis, treatment, prognosis, and public health implications will aid clinician preparedness for this emerging pathogen.

Introduction

Chikungunya is a mosquito-borne viral disease increasingly recognized globally as an emerging pathogen. In December 2013, local transmission of chikungunya virus was reported for the first time in the Americas, leading the Public Health Agency of Canada (PHAC) to alert clinicians and public heath personnel to the possibility of chikungunya in returning travellers presenting with fever and polyarthralgia (1). A recent report from the United States Centers for Disease Control and Prevention (CDC) has identified 25 Caribbean countries with reported cases of autochthonous chikungunya infection (2). In this article, we report an atypical case of chikungunya infection in a traveller returning from Haiti, to highlight clinical features shared by chikungunya and other arthropod-borne infections such as dengue, the important diagnostic tools available to clinicians, and to address concerns around global spread of chikungunya infection.

Background

Chikungunya infection is caused by an alphavirus of the Togaviridae family, and is transmitted primarily by *Aedes aegypti* mosquitoes, and to a lesser extent, *Aedes albopictus* (3).

Chikungunya virus was first described in Tanzania in 1953 (4) and is considered endemic to parts of West Africa. As of September 2014, there were 88 countries reporting transmission of chikungunya infection, including those in Africa, Europe, Oceania, Asia and, most recently, the Americas (5). The first autochthonous infection with chikungunya in a temperate region occurred in Italy in 2007 with a suspected index case originating in India (6). The suspected vector, *Aedes albopictus*, was thought to have acquired a genetic mutation due to ecological pressure allowing it to supplement *Aedes aegypti* as a primary vector (3). As *Aedes albopictus* is widespread in the southeastern United States, there is growing concern about local transmission in these states. In fact, the first case of locally acquired chikungunya infection in the United States was recently reported in a man from Florida (7). Transmission is not expected to occur in Canada, as the *Aedes* mosquitoes are not found in this climate region (1).

In most cases, the presenting symptom is a disabling symmetrical polyarthralgia associated with fever (8). Common joints involved include the ankles, knees, metacarpophalangeal joints, metatarsal joints, shoulders, elbows, and wrists. In approximately one third of patients, joints can be swollen, although effusive arthritis is rare

(8). Following a period of one to three days, there is often development of a diffuse maculopapular rash, usually sparing the face. Arthralgias typically resolve over weeks; however, in many cases, they can persist for months or even years, often having a significant impact on patient quality of life (9).

Clinical diagnosis is challenging as the signs and symptoms of chikungunya overlap with other illnesses, such as parvovirus B19 infection and dengue fever. Microbiologic confirmation is required, and is usually made through detection of immunoglobulin M (IgM) or immunoglobulin G (IgG) antibodies in serum via enzyme-linked immunosorbent assay (ELISA). IgM antibodies are often detected two to six days after onset of symptoms, whereas IgG antibodies usually appear during the convalescent stage of illness and can persist for years (10). Reverse transcription polymerase chain reaction (RT-PCR), performed on serum, plasma or cerebral spinal fluid (CSF), offers the greatest sensitivity and is available through investigational use by the National Microbiology Laboratory in Winnipeg, Manitoba (11). Our case will highlight some of the diagnostic uncertainty surrounding the diagnosis of chikungunya.

Treatment for chikungunya fever is generally supportive, consisting of non-steroidal anti-inflammatory agents, fluids and rest. Corticosteroids are reserved for debilitating arthritis early in the course of acute infection (3). Research into potential monoclonal antibody treatment, antiviral therapy, and vaccinations is ongoing (12, 13).

The case

A 74-year-old man presented to the emergency department with constipation, abdominal pain, and a new onset diffuse non-desquamating maculopapular rash over the chest, back, arms and legs, following an 11-day trip to Haiti from which he returned one day prior to presentation. His rash was non-painful and non-pruritic. A computed tomography (CT) scan was performed of the abdomen showing small bowel diverticular inflammation and possible perforation into the surrounding fatty tissue. He was admitted to hospital for supportive care, including administration of antibiotics. His perforation was presumed secondary to a previous diagnosis of small bowel diverticular disease complicated by significant constipation.

While in Haiti, he had worked as an aid worker in a local health clinic. Prior to travel, he had completed vaccination series for both hepatitis A and B and had been prescribed antimalarial prophylaxis with chloroquine, to which he had been adherent. On day nine of his travel, he awoke with severe diffuse arthralgia affecting both large and small joints in the upper and lower extremities, rigors, and subjective fever. He had no respiratory or gastrointestinal complaints. His arthralgia dramatically improved over a 48-hour period, following which he developed a truncal rash as well as significant constipation, necessitating his presentation to the emergency department.

On physical examination in the emergency department, the patient's abdomen was soft and non-tender. There were no joint swellings noted; however, a maculopapular rash was seen over the chest, and the upper and lower extremities. Cardiac, respiratory and neurologic exams were normal. Routine laboratory investigations were performed (**Table 1**). A significant lymphopenia and thrombocytopenia were noted; chest radiography was also performed on admission and was normal.

Table 1: Routine laboratory investigations upon admission to hospital[1]

Investigation	Value	Reference range
Hemoglobin	143 g/L	132–170 g/L
Leukocytes	9.9 x 10^9/L	3.5–10 x 10^9/L
– Neutrophils	**8.6 x 10^9/L**	2.5–7.5 x 10^9/L
– Lymphocytes	**0.5 x 10^9/L**	1.0–4.0 x 10^9/L
Platelets	**108 x 10^9/L**	130–400 x 10^9/L
AST	36 U/L	13–37 U/L
ALT	18 U/L	10–40 U/L
ALP	94 U/L	40–120 U/L
Bilirubin (total)	11 mmol/L	3.0–20 mmol/L
Sodium	136 mmol/L	135–145 mmol/L
Potassium	4 mmol/L	3.5–5.0 mmol/L
Bicarbonate	22 mmol/L	20–30 mmol/L
Creatinine	79 mmol/L	55–105 mmol/L

Lactate	1.0 mmol/L	0.5–2.0 mmol/L
Urine Cultures	Negative	N/A[2]
Blood Cultures	Negative	N/A[2]
Malaria Rapid Antigen Test[3]	Negative	N/A[2]

[1] Abnormal values are in bold
[2] N/A = Not applicable
[3] Note: Microscopy of Giemsa-stained thin blood smears was also performed.

The patient received supportive care, including intravenous crystalloids, and completed a course of antibiotics in hospital. He was discharged with urgent referral to a tropical diseases clinic for evaluation of his presumed travel-related illness. Dengue virus IgG and IgM antibodies were negative by ELISA. Stool cultures were negative for *Salmonella* spp., *Escherichia coli* O157:H7, *Campylobacter* spp., and *Shigella* spp. Chikungunya IgM antibody was positive by ELISA supporting a probable diagnosis of acute chikungunya infection. Without follow-up confirmatory testing (such as by plaque reduction neutralization test), the possibility of cross-reactivity with other alphaviruses could not be definitively excluded. His abdominal pain resolved in hospital with supportive care alone, while his arthritis and rash completely resolved over a two-week period.

Discussion

We present an atypical case of acute infection with chikungunya in a man returning from Haiti, an area of known ongoing intense dengue and chikungunya transmission. Although the patient's initial symptoms included classic findings of symmetric polyarthritis and subsequent maculopapular rash, his clinical course was complicated by significant abdominal pain, constipation, as well as thrombocytopenia—features atypical of chikungunya. His dramatic improvement over 48 hours is also unusual as polyarthralgia leading to mobility and dexterity issues will frequently last for weeks to months (3). Although uncommon, other atypical manifestations of chikungunya infection have been reported in the literature. These include neurological features (including encephalitis, seizures, and Guillain-Barre syndrome), cardiovascular features (including myocarditis, heart failure, and ischemic heart disease), renal features (including acute kidney injury), ocular features (including optic neuritis), as well as atypical skin eruptions, ulcerations, and bullae (14).

The differential diagnosis of fever and non-effusive polyarthritis is broad. Common bacterial causes include Lyme disease and infective endocarditis. Frequent viral causes include parvovirus B19, hepatitis B and C, rubella, dengue and other alphaviruses, including Mayaro, O'nyong-nyong, Ross River, Barmah Forest, Sindbis, and Semliki Forest virus. Non-infectious etiologies include seronegative spondyloarthropathies, rheumatoid arthritis, crystal-induced arthropathies, and post-infectious (reactive) arthritis. Given our patient's epidemiologic risk and presenting features, the most likely infectious etiologies included dengue fever and chikungunya infection, with parvovirus B19 infection less likely. Disease characteristics, clinical features and laboratory data comparing dengue and chikungunya infection are presented in **Table 2**. Non-infectious causes were deemed unlikely based on the patient's initial fever, rash, and rapid improvement in symptoms.

Table 2: Clinical and laboratory features of chikungunya versus dengue fever

Clinical and laboratory features	Chikungunya	Dengue
Illness Characteristics (19)		
Incubation period	3–7 days (range 2–12)	4–7 days (range 3–14)
Asymptomatic: Symptomatic ratio	0.03:1–0.25:1	2:1–10:1
Clinical Features (3, 8, 9, 17, 19, 20, 21)		
Fever	Common	Common
Arthralgia	Common	Possible
Polyarthritis (without effusion)	Common	Unlikely
Myalgia	Possible	Common
Rash	Common, often day 1–4 of illness	Common, often day 3–7 of illness
Abdominal Pain	Unlikely	Possible

Retro-orbital Pain	Unlikely	Common
Chronic joint pains	Common, can last >2 years	Unlikely
Chronic fatigue	Common, can last >2 years	Common, up to 3 months
Laboratory		
Neutropenia	Possible	Common
Lymphopenia	Common	Common
Thrombocytopenia	Possible	Common

The brisk improvement in the patient's symptoms without supportive care is atypical for chikungunya infection. Although likely related to an atypical presentation of disease, the therapeutic effect of chloroquine to mitigate the symptoms of chikungunya infection has been suggested by in vitro studies (15). However, this effect has not been confirmed by randomized controlled trials in humans (16); thus, it is unclear whether his chloroquine antimalarial prophylaxis attenuated his symptoms.

Constipation leading to abdominal pain is also not a classic feature of chikungunya infection. In a comparative study performed in India, 0 of 131 (0%) patients with acute chikungunya infection reported abdominal pain compared with 22 of 104 (21%) patients with acute dengue (17). However, during an outbreak on Reunion Island, 47% of patients reported gastrointestinal symptoms, although the number with abdominal pain and/or constipation is not reported (8). Given the time course of illness, constipation appears to be associated with this patient's acute chikungunya infection in this case; however, we acknowledge that there may have been two underlying diseases contributing to his symptoms. To explain his constipation and abdominal pain, co-infection with *Salmonella* spp. enteritis remains a possibility, as this infection is frequently associated with constipation and is endemic to Haiti. Stool cultures in this case were drawn only after administration of antibiotics, which substantially decreases their yield and may have been falsely negative.

Conclusion

Chikungunya infection is becoming a global concern as countries reporting new transmissions increase. The ability for viral mutation under selective pressure along with growing worldwide travel gives chikungunya significant epidemic potential. Given the varied clinical features at presentation, clinicians need to be vigilant in considering chikungunya infection in patients returning from high-risk countries with fever and polyarthralgia, regardless of other clinical and laboratory features. Although treatment is generally supportive, patient symptoms, including a debilitating arthritis, can persist for years, stressing the importance of patient education in appropriate mosquito bite prevention techniques during travel, including use of DEET- or icaridin-based insect repellants and protective clothing (18).

Conflict of interest

None

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References

(1) Deilgat M, Geduld J, Drebot, M. Chikungunya outbreak in the Caribbean 2013–2014. CCDR. 2014 Jan;40(2):7–12. www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40-02/dr-rm40-02-chik-eng.php

(2) Centers for Disease Control and Prevention. Chikungunya in the Caribbean. www.nc.cdc.gov/travel/notices/watch/chikungunya-caribbean

(3) Thiboutot MM, Kannan S, Kawalekar OU, Shedlock DJ, Khan AS, Sarangan G, et al. Chikungunya: A potentially emerging epidemic? PLoS Negl Trop Dis. 2010;4:e623.

(4) Lumsden WH. An epidemic of virus disease in Southern Province, Tanganyika Territory, in 1952–53. II. General description and epidemiology. Trans R Soc Trop Med Hyg. 1955 Jan;49(1):33–57.

(5) Centers for Disease Control and Prevention. Geographic distribution—Where has chikungunya virus been found? www.cdc.gov/chikungunya/geo/index.html

(6) Rezza G, Nicoletti L, Angelini R, Romi R, Finarelli AC, Panning M. Infection with chikungunya virus in Italy: An outbreak in a temperate region. Lancet. 2007 Dec 1;370(9602):1840–6.

(7) McCarthy M. First case of locally acquired chikungunya is reported in US. BMJ. 2014 Jul 18;349.

(8) Borgherini G, Poubeau P, Staikowsky F, Lory M, Le Moullec N, Becquart JP, et al. Outbreak of chikungunya on Reunion Island: early clinical and laboratory features in 157 adult patients. Clin Infect Dis. 2007;44:1401–7.

(9) Marimoutou C, Vivier E, Oliver M, Boutin JP, Simon F. Morbidity and impaired quality of life 30 months after chikungunya infection: Comparative cohort of infected and uninfected French military policemen in Reunion Island. Medicine (Baltimore). 2012 Jul;91(4):212–9.

(10) Niedrig M, Zeller H, Schuffenecker I, Drosten C, Emmerich P, Rumer L, et al. International diagnostic accuracy study for the serological detection of chikungunya virus infection. Clin Microbiol Infect. 2009;15:880–4.

(11) Schwartz KL, Giga A, Boggild AK. Chikungunya fever in Canada: Fever and polyarthritis in a returned traveller. CMAJ. 2014 Jul 8;186(10):772–4.

(12) Chang LJ, Dowd KA, Mendoza FH, Saunders JG, Sitar S, Plummer SH. Safety and tolerability of chikungunya virus-like particle vaccine in healthy adults: A phase 1 dose-escalation trial. Lancet. 2014 Dec 6;384(9959):2046–52. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)61185-5/fulltext

(13) Powers AM. Chikungunya virus control: Is a vaccine on the horizon? Lancet. 2014 Dec 6;384(9959):2008–9. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)61290-3/fulltext

(14) Rajapakse S, Rodrigo C, Rajapakse A. Atypical manifestations of chikungunya infection. Trans R Soc Trop Med Hyg. 2010 Feb;104(2):89–96.

(15) Khan M, Santhosh SR, Tiwari M, Lakshmana Rao PV, Parida M. Assessment of in vitro prophylactic and therapeutic efficacy of chloroquine against Chikungunya virus in vero cells. J Med Virol. 2010 May;82(5):817–24.

(16) Chopra A, Saluja M, Venugopalan A. Effectiveness of chloroquine and inflammatory cytokine response in patients with early persistent musculoskeletal pain and arthritis following chikungunya virus infection. Arthritis Rheumatol. 2014 Feb;66(2):319–26.

(17) Taraphdar D, Sarkar A, Mukhopadhyay BB, Chatterjee S. A comparative study of clinical features between monotypic and dual infection cases with Chikungunya virus and dengue virus in West Bengal, India. Am J Trop Med Hyg. 2012 Apr;86(4):720–3.

(18) Schofield S, Plourde P, for the Committee to Advise on Tropical Medicine and Travel (CATMAT). Statement on Personal Protective Measures to Prevent Arthropod Bites. CCDR 2012;38(ACS-3):1–18.

(19) Chen LH, Wilson ME. Dengue and chikungunya in travelers. Curr Opin Infect Dis. 2010 Oct;23(5):438-44.

(20) Queyriaux B, Simon F, Grandadam M, Michel R, Tolou H, Boutin JP. Clinical burden of chikungunya virus infection. Lancet Infect Dis. 2008 Jan;8(1):2-3.

(21) Potts JA, Rothman AL. Clinical and laboratory features that distinguish dengue from other febrile illnesses in endemic populations. Trop Med Int Health. 2008 Nov; 13(11):1328-40.

Is there a risk of chikungunya transmission in Canada?

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Abstract

An outbreak of chikungunya virus infection is currently underway in the Caribbean, Central America and South America, and autochthonous (local or indigenous) transmission has occurred in the southeastern United States. The mosquito species known to transmit chikungunya—*Aedes aegypti* and *Aedes albopictus*—are not known to reside in Canada at this time. But how comfortable can we be that this situation will continue? Here we explore four key conditions that must be met for transmission of chikungunya within Canada. We conclude that not all of these conditions have been met and the risk of chikungunya transmission in most of Canada appears to be very low at present. The risk is slightly higher in warmer areas, such as southern British Columbia and isolated locations in south central and southeastern Canada. However, there are significant gaps in our knowledge and ongoing risk assessment, research and surveillance for vectors of chikungunya are indicated.

Introduction

The mosquito-borne viral illness chikungunya is endemic to parts of Africa, Asia, and the Indian and Pacific Oceans. In December 2013, two autochthonously (locally or indigenously) transmitted cases of chikungunya on the Caribbean island of Saint-Martin/Sint Maarten marked the beginning of an outbreak in the western hemisphere. Over the course of 2014, chikungunya spread through much of the Caribbean, as well as parts of Central America, South America and Mexico, with autochthonous transmission being seen in the southeastern United States (1, 2).

A rapid increase in laboratory diagnoses of travel-acquired chikungunya infections in Canadians has been seen recently (3). This would be expected, given the high numbers of Canadians who travel to affected regions for business and pleasure (3). In addition to the direct risk of infections being acquired during travel, what is the risk that travellers who have acquired infection abroad return and act as a source of local autochthonous chikungunya transmission in Canada? In this article, we evaluate the possibility of local transmission of chikungunya virus in Canada that could lead to isolated autochthonous cases or outbreaks.

Analysis

There are four conditions that must be met for local transmission of chikungunya to occur: the introduction of the virus; the presence of a competent vector; suitable climactic conditions for virus transmission; and a sufficient number of susceptible people. We examine each of these conditions below and identify whether or not these conditions are currently present in Canada.

Introduction of chikungunya virus

Travellers, including Canadians, who acquire chikungunya are frequently viraemic on their return and could be the source for infection of Canadian residents if competent vector mosquitoes were present and other conditions of transmission were met (3). Infected, viraemic returning travellers are thought to be the most important source of international spread of chikungunya virus and the most likely source of introduction of infection for outbreaks in Italy, as well as autochthonous cases in France and the United States (4, 5, 6). Introduction of infected mosquitoes could occur with international trade through products that carry live infected mosquitoes from affected

regions (4). Studies are underway to identify potential hotspots in Canada for introduction of chikungunya virus in people or mosquito-contaminated imports.

Presence of a competent vector

For transmission to occur in Canada from an infected returning traveller to a susceptible Canadian resident, mosquitoes of a species capable of transmitting the virus must be present. The only two vectors known to be capable of transmitting chikungunya virus, and to have played a role in a chikungunya outbreak, are the mosquitoes *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito) (2,4). The main determinant of where these mosquitoes can become established is climate. Both species are implicated in the transmission of chikungunya in the current outbreak in the Americas (1).

Aedes aegypti is a mosquito adapted to sub-tropical and tropical regions and is unlikely to become established in Canada under our current climate conditions or even with climate change (7). *Aedes albopictus*, however, can survive cooler northern temperatures. It is able to survive cold winters, and became established in parts of the United States in the 1980s (8). This mosquito now occurs in central and eastern regions of the U.S., and extending to the southern parts of states that border Canada, including New York, Pennsylvania and Ohio. It has also occurred in, and been eradicated from, several western states (8). However, our current knowledge of where *Aedes albopictus* is in North America is based primarily on informal surveillance and field studies. Surveillance that would identify whether and where this mosquito is becoming established in risk areas in Canada is being planned with provincial partners.

Recent studies suggest that the climate in most of Canada (except for southern coastal British Columbia and some locations in south central and southeastern Canada) is not suitable for long-term survival of the *Aedes albopictus* mosquito (9). There are rare reports of this mosquito in Canada (10), but there is no evidence that it has become established in any part of Canada. This situation may change with a changing climate. Assessing how much change would be needed for *Aedes albopictus* mosquitoes to become established needs more research (9).

Presence of suitable climatic conditions

There are two climatic factors that determine whether conditions are suitable for chikungunya transmission. First, the climate has to be suitable to support not only reproducing populations of the mosquito species, but populations with an abundance high enough such that at least one mosquito acquires chikungunya virus from an infected person and survives to transmit it to an uninfected person. Second, the temperature conditions have to be warm enough for chikungunya virus to spread from the mosquito's gut (where the virus is first present after being acquired from an infected person) to the salivary glands (from which the virus is transmitted in saliva when the mosquito next feeds) before the mosquito dies. Recent studies suggest a threshold temperature of 20°C for the occurrence of outbreaks of chikungunya based on past experiences (10). We are currently investigating where and when climatic conditions are suitable for chikungunya transmission in Canada under current and future climate. Outputs of this research will be combined with assessments of where risk mosquito vectors may occur to improve our assessment of risk of autochthonous transmission and to guide public health programs.

Presence of sufficient numbers of susceptible people

If there were locations in Canada where competent mosquitoes were established in sufficient numbers for transmission and were exposed to infected persons returning from affected countries, individual autochthonous cases of chikungunya could occur. However, for transmission to be sustained in the short or long term, infected mosquitoes would need to have access to a sufficient number of susceptible people.

In developing countries, mosquitoes have relatively free access to both buildings and the people that occupy them. In countries such as Canada, however, residences and businesses are mostly well-sealed off from the incursion of mosquitoes, and mosquito bites mostly occur when people are outside. Typically, this does not involve large crowds of people, but rather hikers, gardeners, and others in relatively low density. In the absence of sufficient numbers of humans, infected *Aedes albopictus* mosquitoes may be more likely to feed on wild or domesticated animals, thus inhibiting transmission in humans. These socioeconomic factors are thought to limit the transmission of other vector-borne diseases, such as dengue, and will likely be a key factor in dampening any putative autochthonous transmission of chikungunya in countries such as Canada (11).

Discussion and conclusion

In light of the current outbreak of chikungunya occurring south of us in the Americas, assessing the risks of autochthonous cases or limited outbreaks of chikungunya in Canada is indicated. At present, there is no evidence that competent vectors of chikungunya, such as *Aedes albopictus*, are established in Canada, and climatic conditions appear currently mostly unsuitable or sub-optimal for this species. Therefore, presently, the risk of autochthonous cases and outbreaks of chikungunya in Canada appears to be very low. However, the risk is slightly higher in warmer climate areas, such as southern British Columbia and isolated locations in south central and southeastern Canada. Furthermore, socioeconomic factors may also be unfavourable for human-to-mosquito-to-human transmission of the virus.

The primary risk of autochthonous transmission in Canada would arise from *Aedes albopictus* mosquitoes becoming established here. Our knowledge of its current whereabouts is based on informal surveillance. More field research is needed in North America to better understand and predict the climatic limits of this species (10).

Several factors could alter this assessment. Temperatures suitable for chikungunya virus transmission are achieved at times in many parts of Canada during the summer (9), and it is possible that in some circumstances housing conditions and densities of uninfected people would be sufficient to sustain limited outbreaks. Furthermore, it is possible that genetic plasticity of mosquito species could improve their capacity to survive in cooler, more northerly climates, although this is difficult to predict (10). Finally, viral mutations could theoretically result in viruses becoming transmissible by other vectors that are established in Canada (2).

In conclusion, our observations suggest that the current risk of autochthonous spread of chikungunya virus in Canada is very low, but there are gaps in our knowledge and several factors could alter this risk assessment. This suggests the need for ongoing risk assessment, consideration of the projected effects of climate change, surveillance for human cases of chikungunya, enhanced surveillance for mosquito vectors, and the development of plans for prevention and control of outbreaks of this and other exotic vector-borne diseases that may threaten the health of Canadians in the coming decades.

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Conflict of interest

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References

(1) Pan American Health Organization. Number of reported cases of chikungunya fever in the Americas—EW 40 (October 24, 2014). http://www.paho.org/hq/index.php?option=com_topics&view=article&id=343&Itemid=40931
(2) Powers AM. Risks to the Americas associated with the continued expansion of Chikungunya virus. J Gen Virol. 2014 pii: vir.0.070136-0.
(3) Drebot, MA, Holloway K, Zheng H, Ogden NH. Travel-related Chikungunya cases in Canada, 2014. CCDR. 2015 Jan 8;41(1):2–6.http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol41/index-eng.php
(4) Charrel RN, De Lamballerie X, Raoult D. Chikungunya outbreaks—The globalization of vectorborne diseases. N Engl J Med. 2007;356:769–71.
(5) La Ruche G, Souarès Y, Armengaud A, Peloux-Petiot F, Delaunay P, Desprès P, et al. First two autochthonous dengue virus infections in metropolitan France. Euro Surveill. 2010;15:19676.
(6) Johansson MA, Powers AM, Pesik N, Cohen NJ, Staples JE. Nowcasting the spread of chikungunya virus in the Americas. PLoS One. 2014;9:e104915.
(7) Khormi HM, Kumar L. Climate change and the potential global distribution of *Aedes aegypti*: Spatial modelling using GIS and CLIMEX. Geospat Health. 2014;8:405–15.

(8) Moore CG. *Aedes albopictus* in the United States: Current status and prospects for further spread. J Am Mosq Control Assoc. 1999;15:221–7.
(9) Fischer D, Thomas SM, Suk JE, Sudre B, Hess A, Tjaden NB, et al. Climate change effects on Chikungunya transmission in Europe: Geospatial analysis of vector's climatic suitability and virus' temperature requirements. Int J Health Geogr. 2013;12:51.
(10) Ogden NH, Radojevic M, Caminade C, Gachon P. Recent and projected future climatic suitability of North America for the Asian tiger mosquito *Aedes albopictus*. Parasites & Vectors. 2014 Dec 2;7:532.
(11) Reiter P. Climate change and mosquito-borne disease. Environ Health Perspect. 2001;109(Suppl 1):141–61.

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